

1. A magnetic suspension system comprising  
a guideway comprising one or more ferromagnetic rails, at least one of which further comprises windings for a linear synchronous motor;  
a vehicle comprising one or more arrays of magnets at least one of which:  
    effects magnetic attraction forces to at least one guideway rail;  
    effects lateral restoring forces on the vehicle; and  
    effects longitudinal forces in response to electrical current in one or more of the windings;  
at least one control coil wound around the magnets effecting a substantially stable vertical gap.
2. A magnetic suspension system according to claim 1, comprising a first control system effective for controlling the coils.
3. A magnetic suspension system according to claim 2, comprising a second control system effective for driving the windings of the synchronous motor.
4. The system of claim 1, further comprising at least one pair of magnets disposed in a lateral offset manner to damp any of sway and yaw forces.
5. The system of claim 1, further comprising one or more devices disposed on the vehicle effective to damp any of heave, roll, sway and yaw oscillations.
6. The system of claim 1, further comprising a linear synchronous motor effective to produce substantially smooth forces without producing substantial cogging forces.
7. The system of claim 1, further comprising a position sensing system effective to determine the position of the vehicle with respect to the guideway.
8. The system of claim 1, wherein the array of magnets further comprises end magnets of a size and location effecting minimal end effects and cogging forces.
9. The system of claim 8, wherein the array of magnets further comprises at least one pair of magnets disposed at a lateral offset.
10. The system of claim 8, further comprising one or more devices disposed on the vehicle effective to damp any of heave, sway and yaw oscillations.
11. A magnetic suspension system comprising  
a guideway comprising one or more ferromagnetic rails, at least one of which further comprises windings for a linear synchronous motor;  
a vehicle comprising one or more arrays of superconducting magnets, at least one of which:

effects magnetic attraction forces to at least one guideway rail;  
effects lateral restoring forces on the vehicle; and  
effects longitudinal forces in response to electrical current in one or more of the windings;

a system effective to substantially stabilize a vertical gap.

12. A system according to claim 11, comprising a winding control system effective to produce acceleration forces.

13. A magnetic suspension system comprising  
a guideway comprising one or more ferromagnetic rails, at least one of which further comprises windings for a linear synchronous motor;  
a vehicle comprising at least one array of superconducting magnets, at least one of which:

effects magnetic attraction forces to at least one guideway rail;  
effects lateral restoring forces on the vehicle; and  
effects longitudinal forces in response to electrical current in one or more of the windings;

at least one control coil wound around the magnets effecting a substantially stable vertical gap;

a first control system effective for controlling the coils; and

a second control system effective for driving the windings effective to produce acceleration of the vehicle.